

Construction

Chapter 13

ct4310 - Bed, bank and shoreline protection

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June 3, 2012

Faculty of Civil Engineering and Geosciences
Section Hydraulic Engineering

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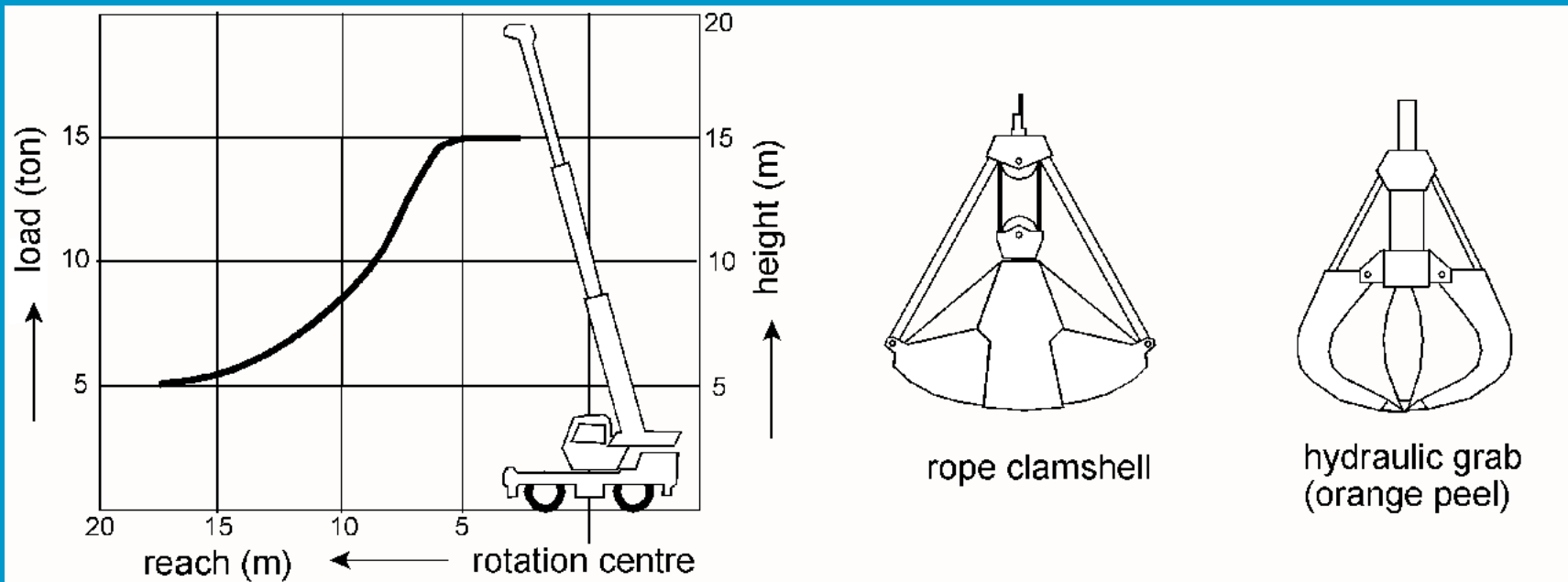


Delft University of Technology

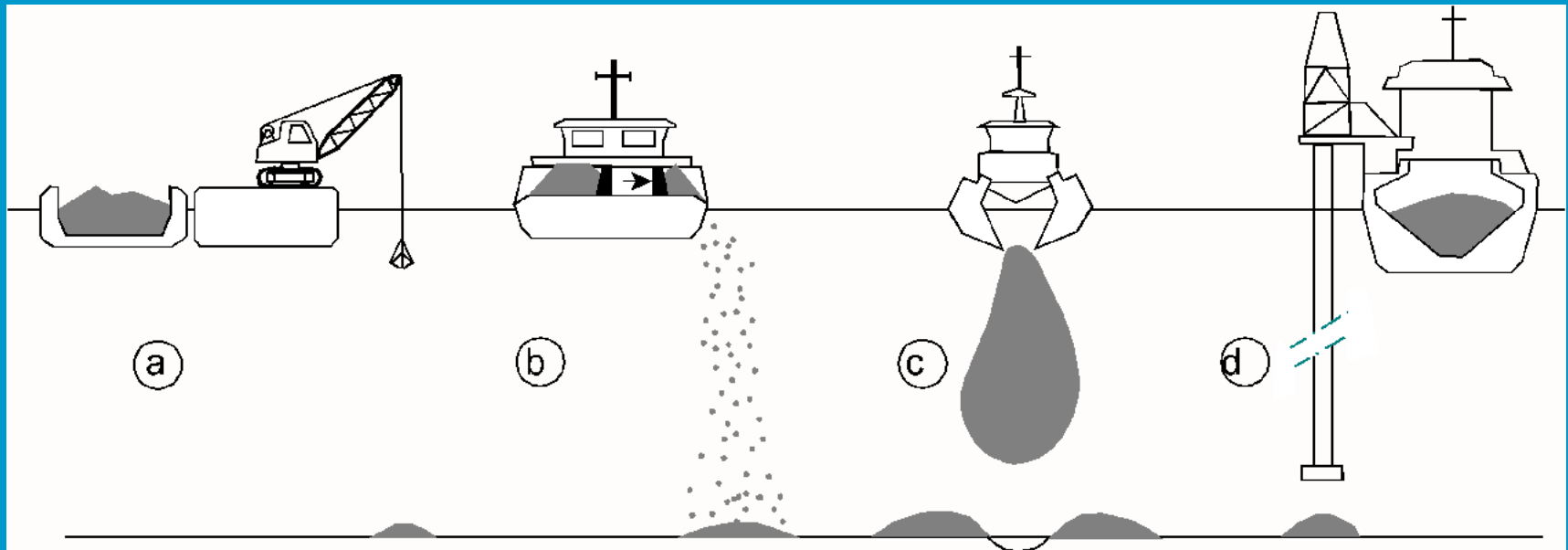
Introduction

- Making a design is one thing, but placing is another point
- Various types of equipment can be used
- Always you have to make a choice between land-based and floating equipment

crane capacity and accessories



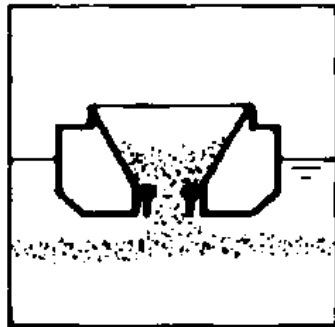
some examples of waterborne equipment



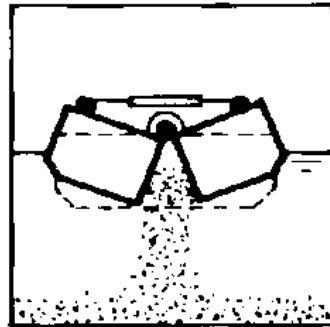
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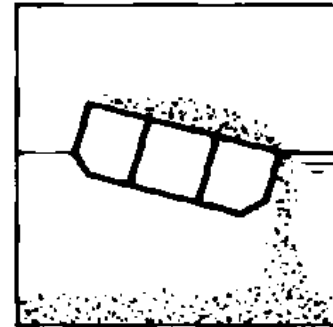
types of dumpers



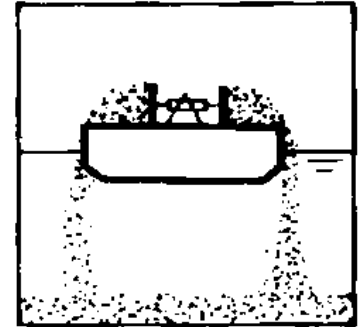
Bottom-door barge



Split barge

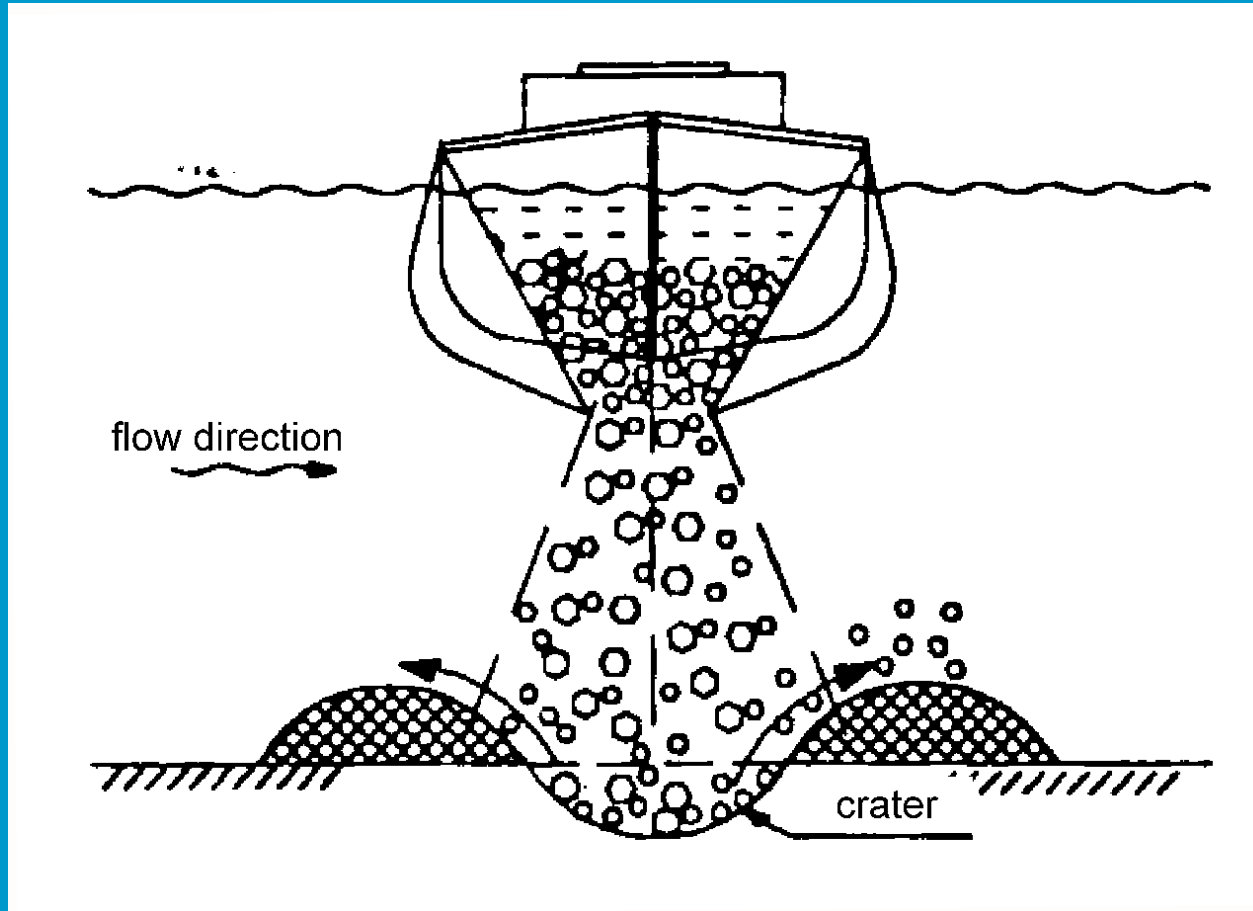


Tilting barge



Side-unloading barge

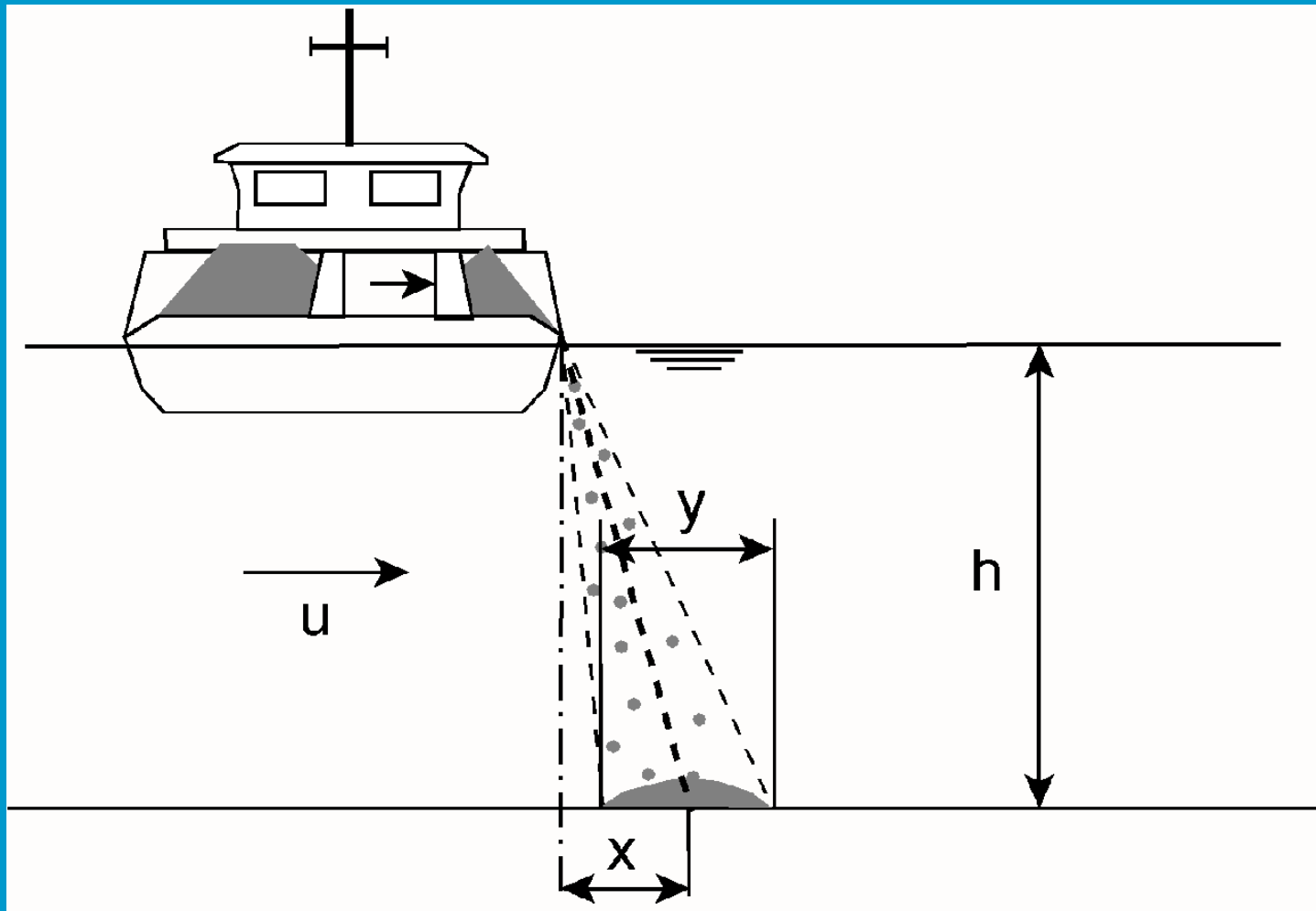
crater formation



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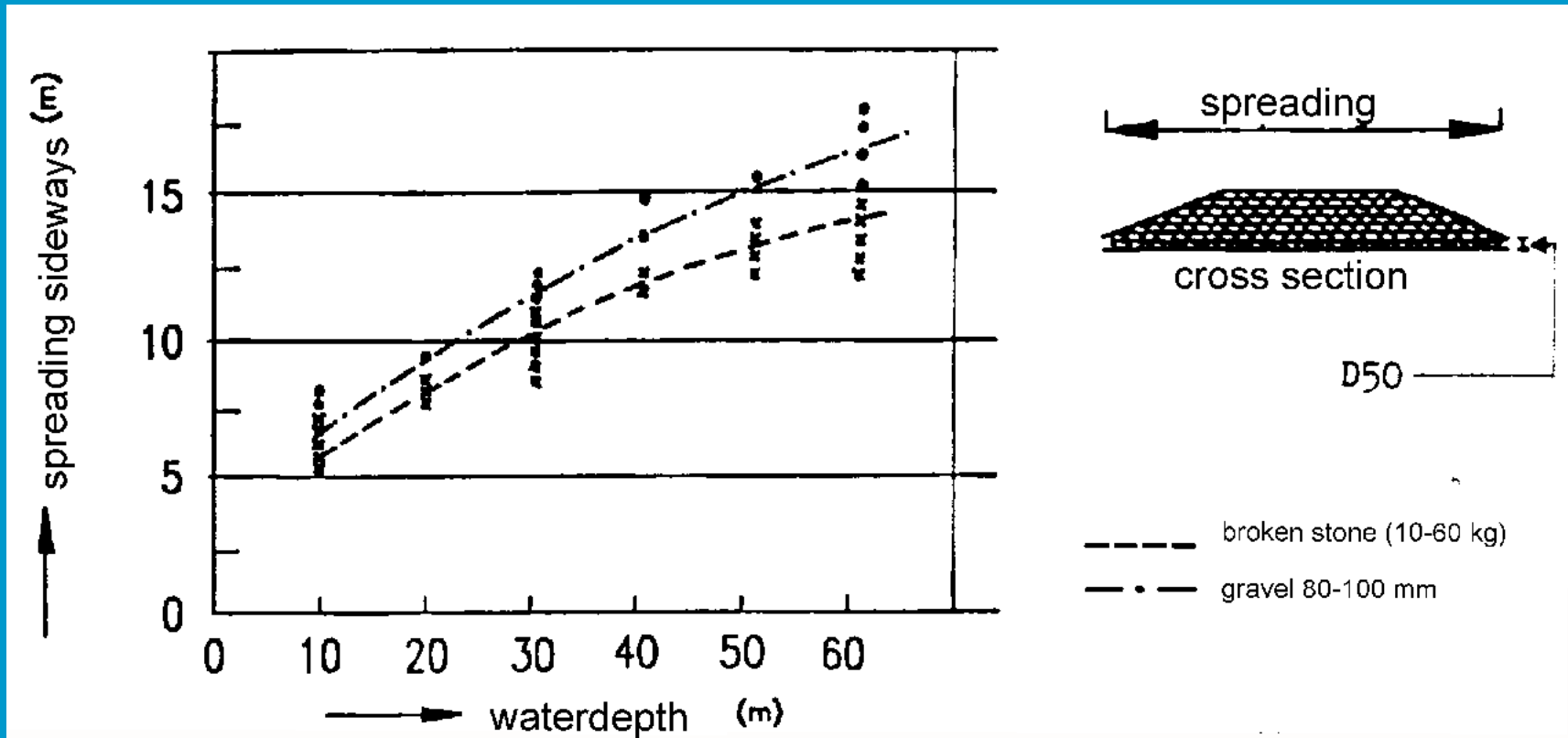
deviations from dumping location



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spreading



fall velocity and distribution

$$m g = F_D \rightarrow (\rho_s - \rho_w) d_{n50}^3 g = C' \rho_w u^2 d_{n50}^2 \rightarrow u_{Fall} = C' \sqrt{\Delta g d_{n50}}$$

$$x = C \frac{h u}{\sqrt{g \Delta d_{n50}}}$$

x is the deviation from the vertical line

C is a coefficient in the order of 0.7 to 0.8

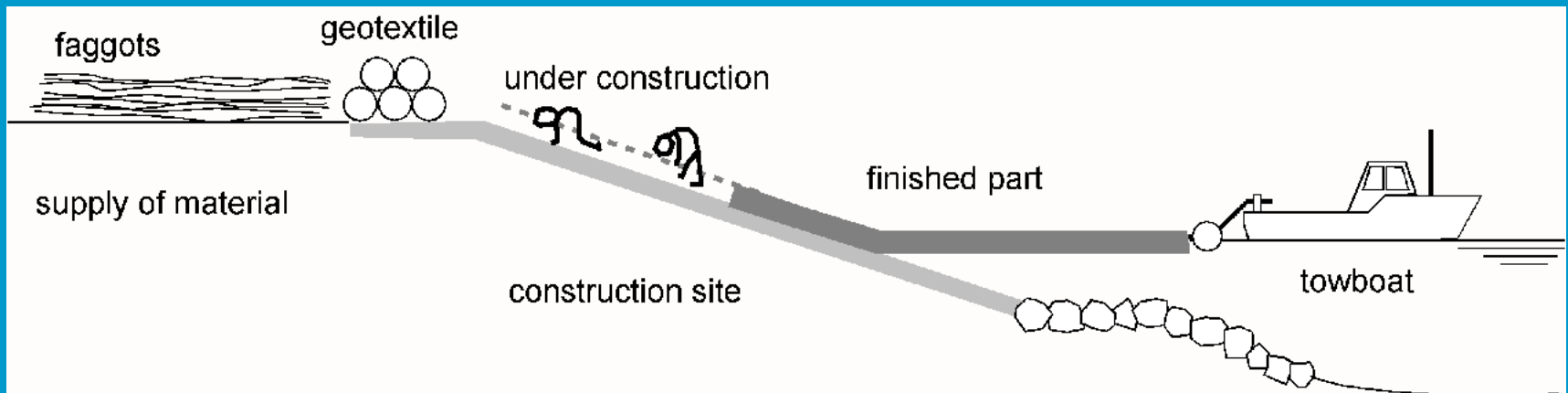
$$y = K \sqrt{h}$$

y is the standard deviation of x

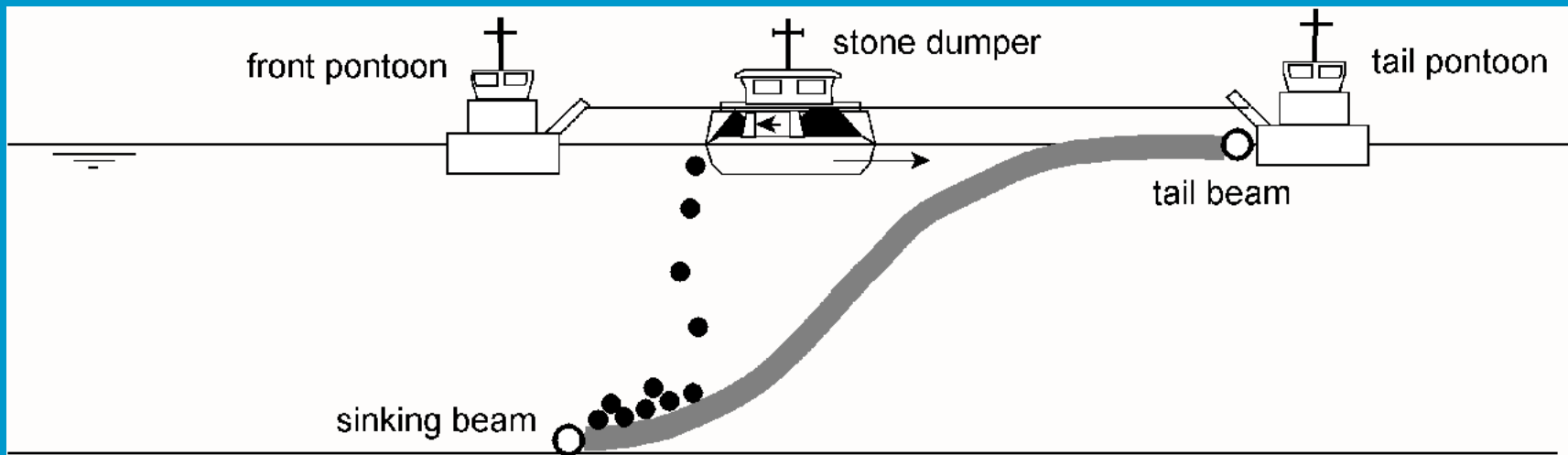
K is $1.9\sqrt{m}$ for broken stone

$2.1\sqrt{m}$ for rounded stone

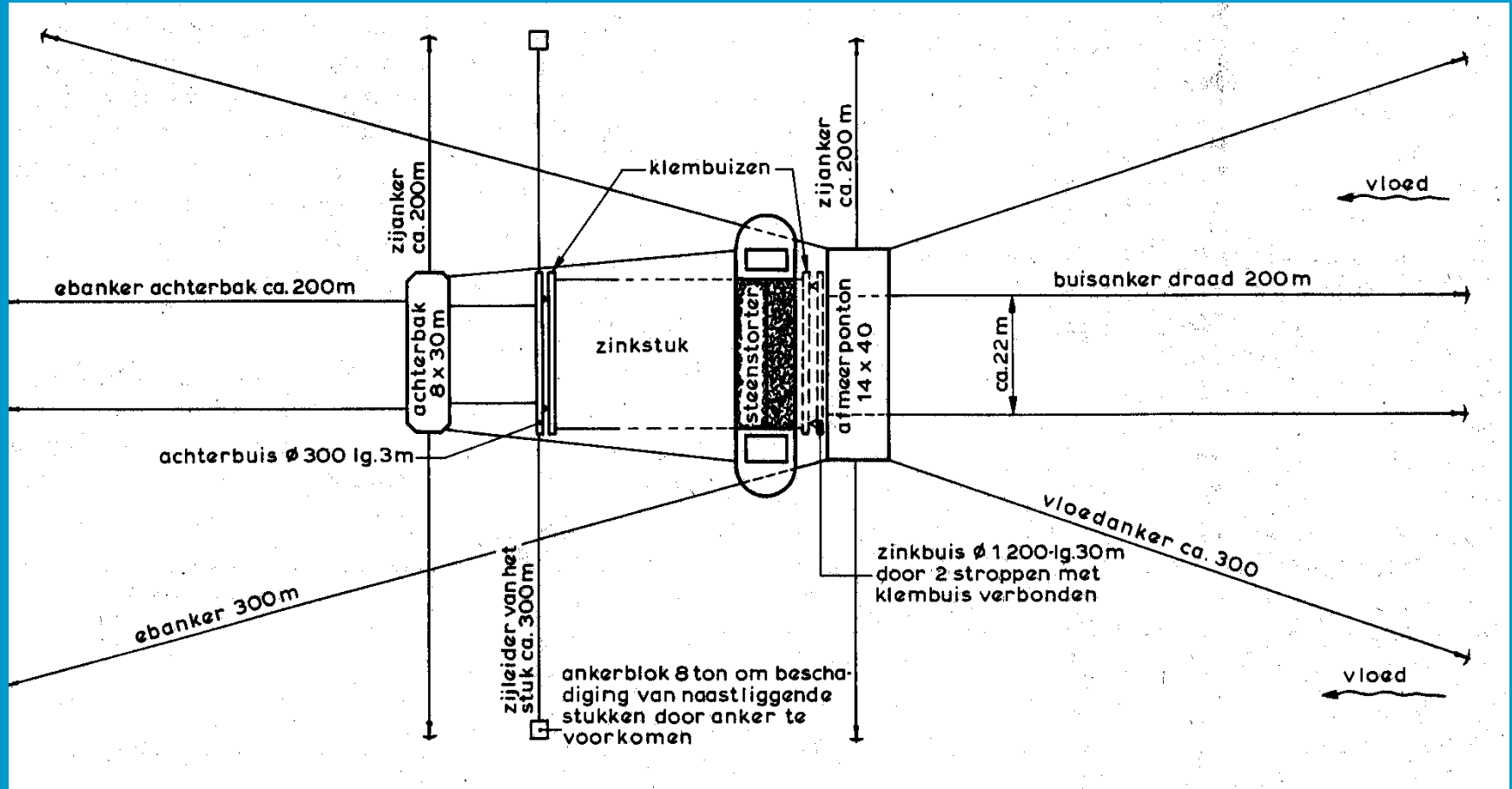
construction of a fascine mattress



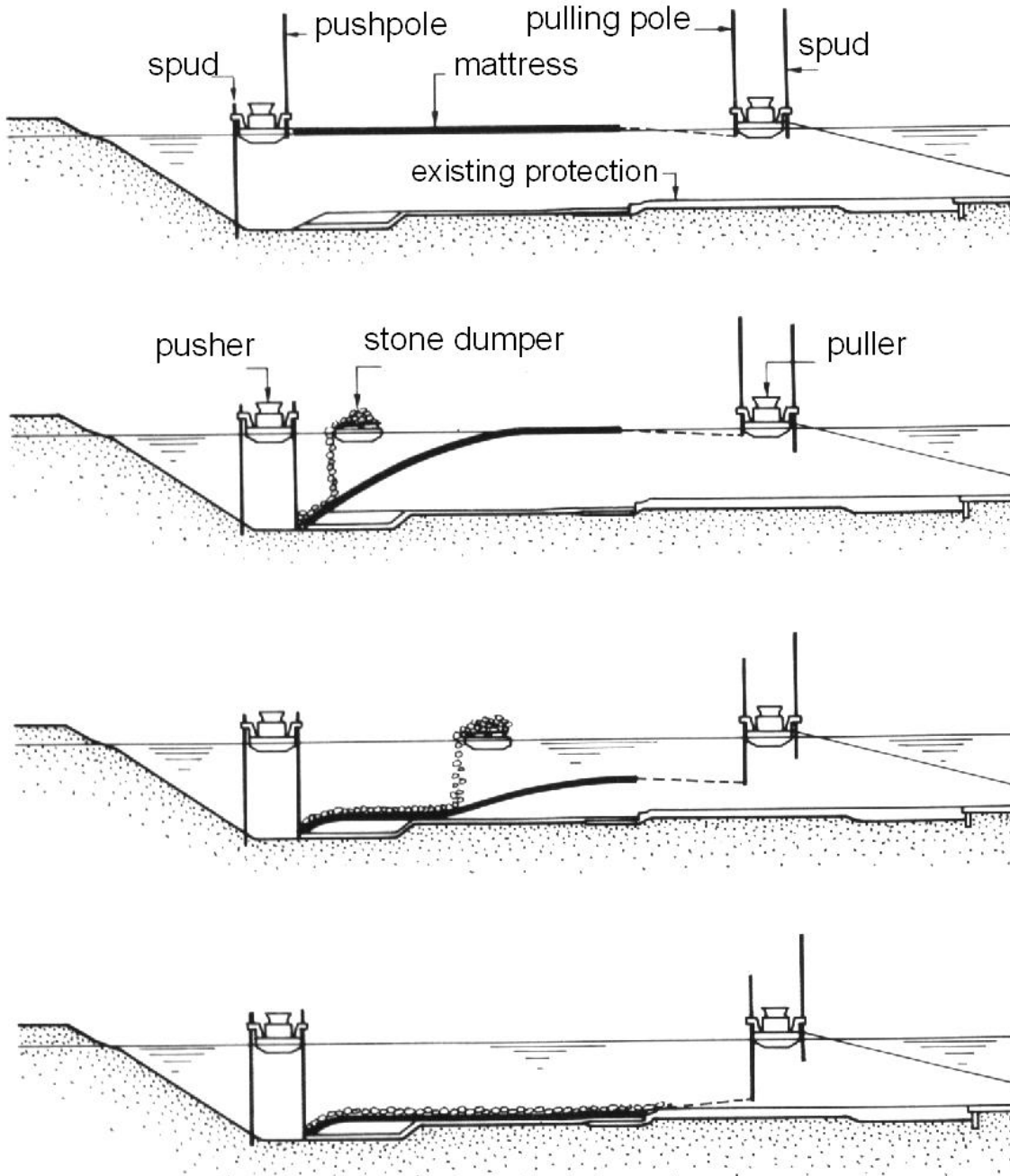
the sinking process



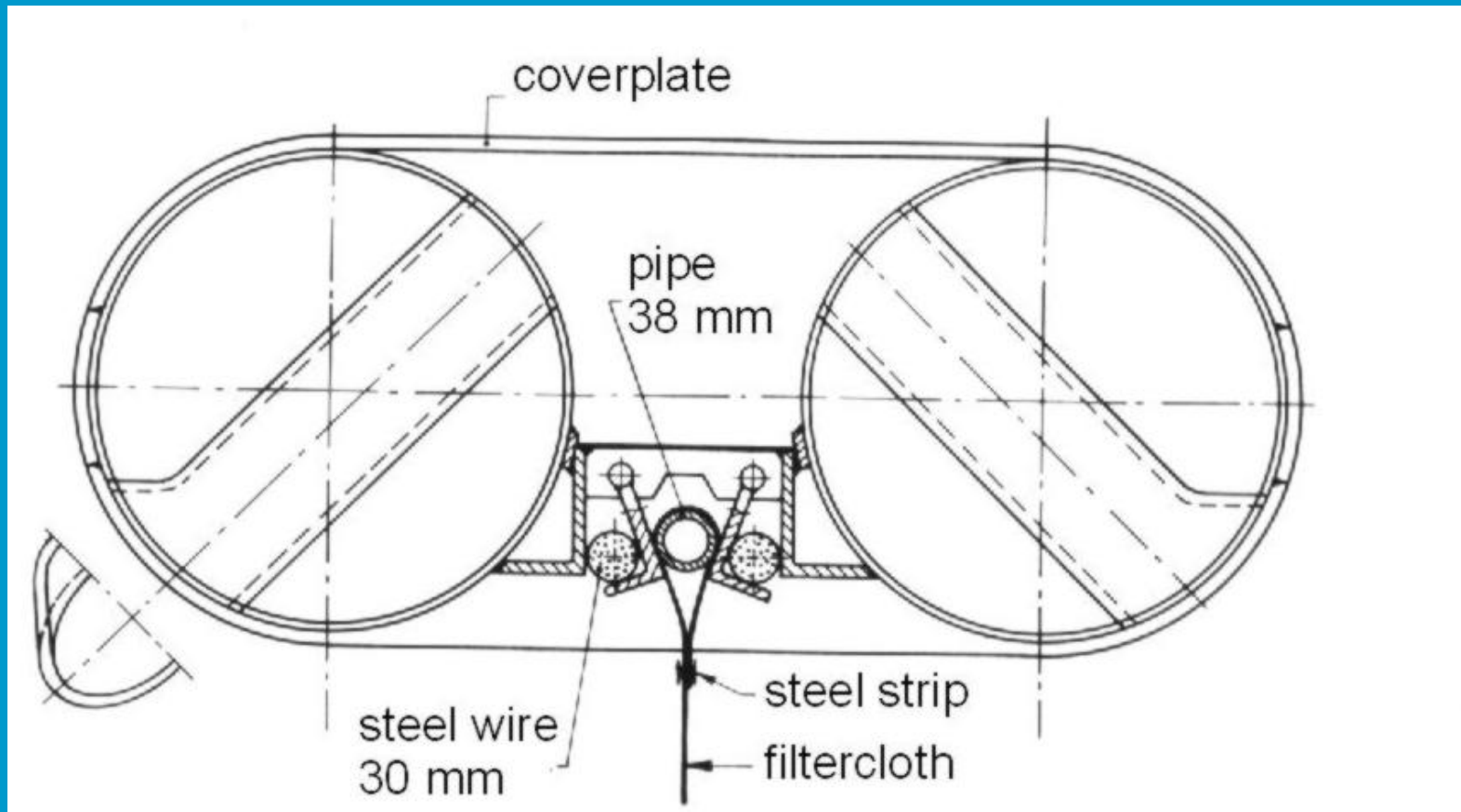
Anchors for sinking



Placing procedure of a mattress under current conditions



Sinking tube



Examples

- Sinking can also be done using sandbags.
- Pipeline cover in the UK
- Abidjan

rock grading

range	D_{50} (cm)	M_{50} (kg)	D_{n50} (cm)	Layer thickness 1.5 D_{n50} (cm)	Minimal dumping quantity with layer of 1.5 D_{n50} (kg/m ²)
30/60 mm	3.9-4.9	0.09-0.18	3.7	20	300
40/100 mm	6.2-8.8	0.35-1.04	6.3	20	300
50/150 mm	8.8-12.3	1.04-2.79	8.9	20	300
80/200 mm	12.3-17.7	2.79-8.31	12.6	20	300
5-40 kg	21-26	12-25	19	29	450
10-60 kg	26-31	24-43	24	36	550
40-200 kg	38-44	84-131	35	53	800
60-300 kg	45-51	139-204	41	62	950
300-1000 kg	71-77	541-692	63	95	1450
1-3 ton	103-110	1620-1980	90	135	2050
3-6 ton	136-143	3843-4392	118	177	2700
6-10 ton	167-174	7050-7790	144	216	3250

Standard rock grading: example

- ELL (2%)
2 kg
- NLL (10%)
10 kg
- NUL (70%)
60 kg
- EUL (97%)
120 kg
- Range M_{50}



Standard gradings defined in EN 13383 and Rock Manual

What is the diameter of a rock?

- Length-to-thickness ratio (LT) = l/d
- Defined in EN 13383
- Usually $LT > 3$
limited to eg 5%
- 'Blockiness'
 $Blc = (M/\rho) / (X \cdot Y \cdot Z)$

What is the diameter of a rock?

- Equivalent diameters:
 - Nominal diameter (equivalent cube):
$$D_n = (M/\rho)^{1/3}$$
 - Sometimes also used: equivalent sphere
$$D_s = (6/\pi)^{1/3} \cdot (M/\rho)^{1/3} = 0.81 \cdot D_n$$
- 'Sieve' diameter D = diameter of (hypothetical) square sieve the rock would just fit through. Equivalent to 'grain diameter' in sands.
- Commonly used conversion ratio:
 - $F_s = (M/\rho) / D^3 = 0.6$ (varies 0.32 – 0.72)
 - $D_n / D = F_s^{1/3} = 0.84$

bed protection around the head of a groyne

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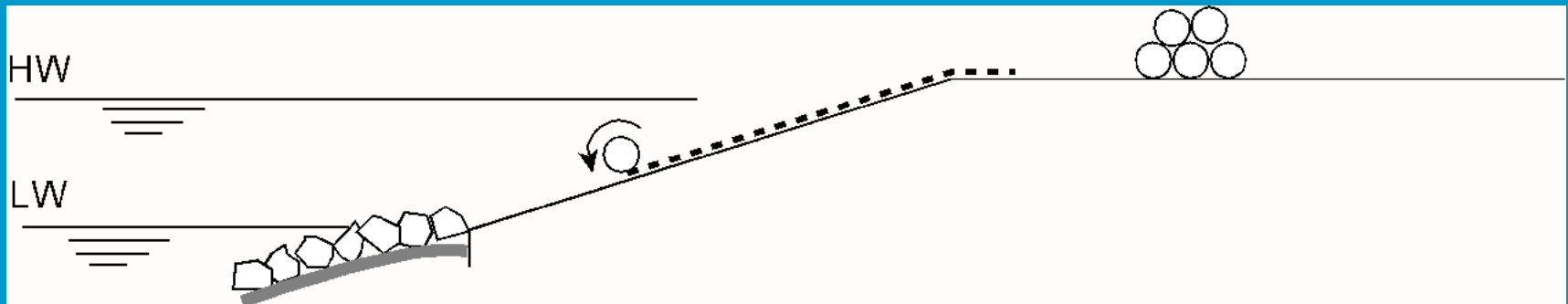
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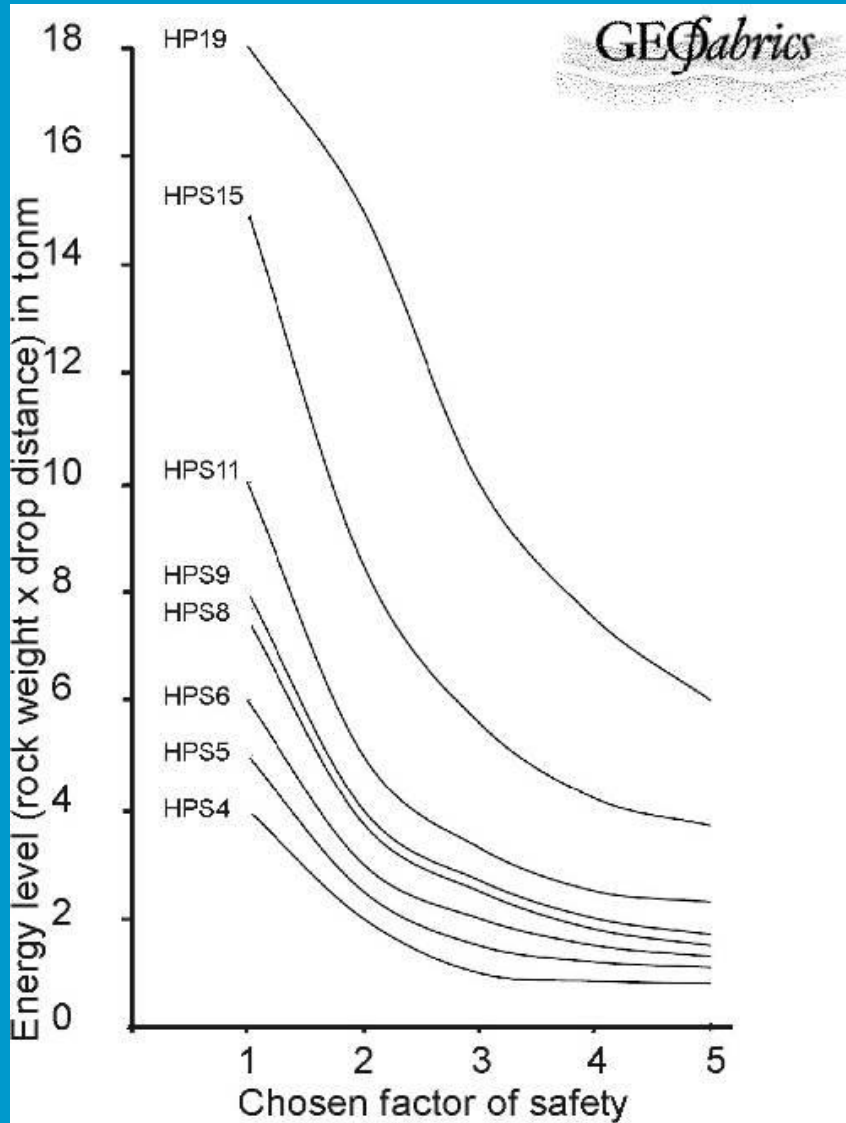
placing geotextile in simple revetments

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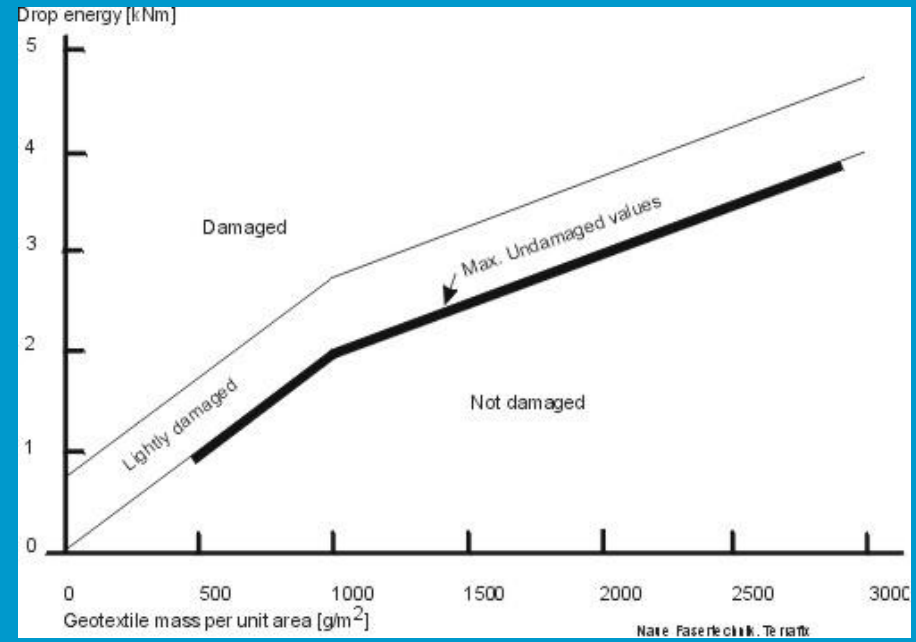
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rolling down a geotextile

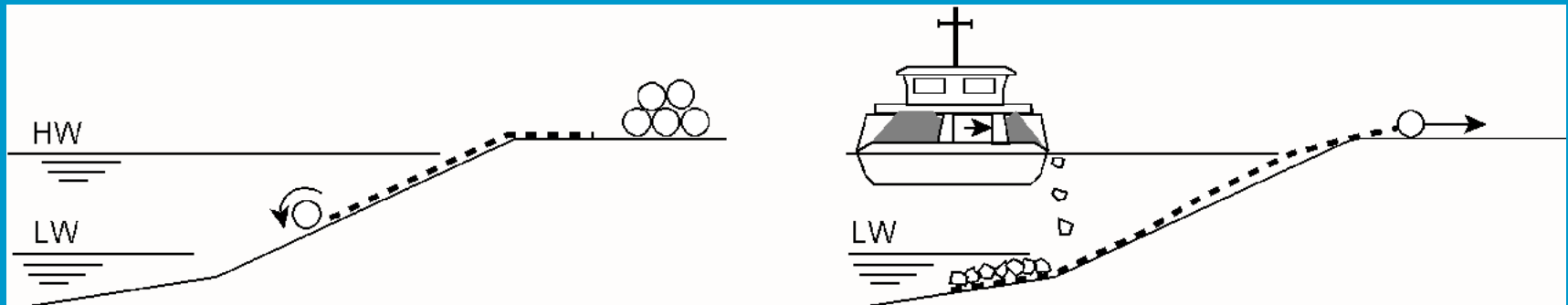




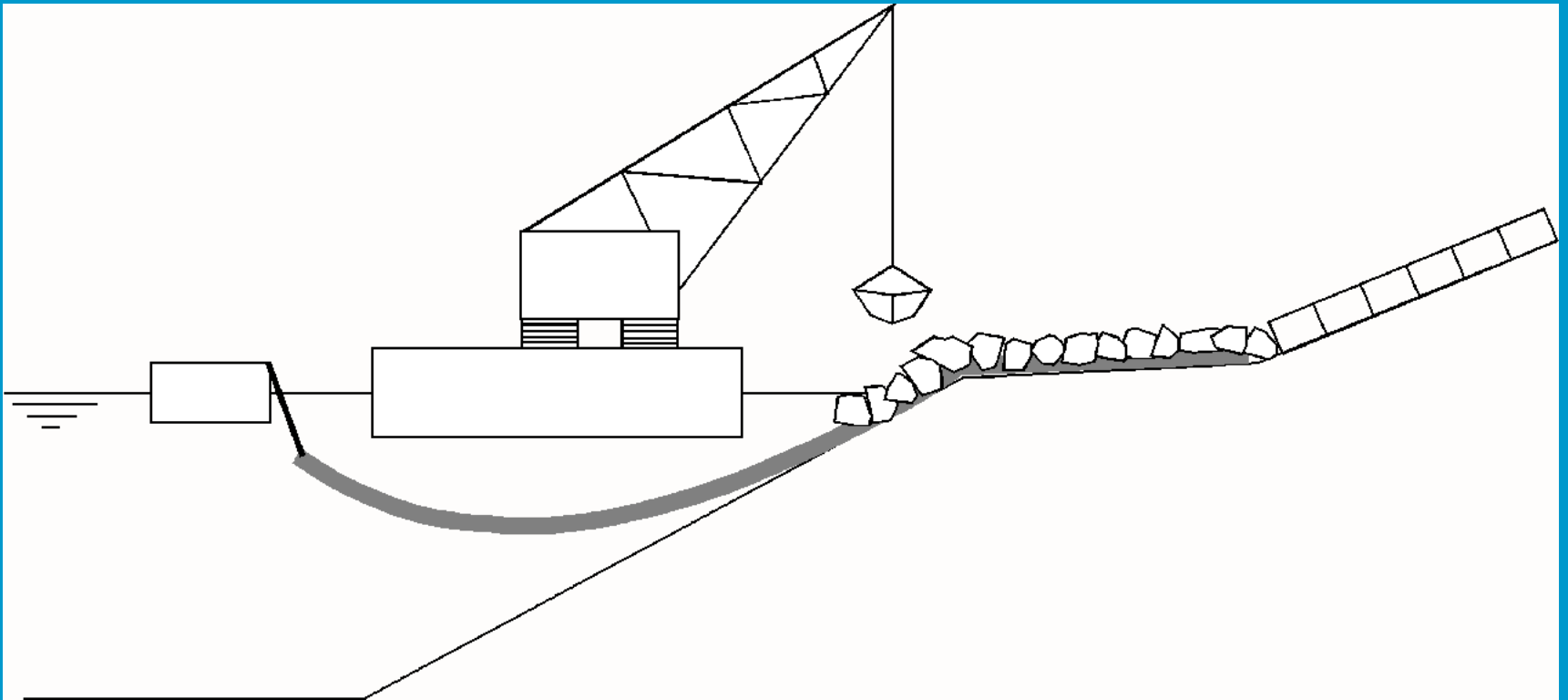
Required geotextile strength



construction of a simple revetment with side stone dumping vessel



placing fascine mattress on a revetment



kraagstuk

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Shoreline protection Singapore



Boskalis Westminster



Wouter Saers, 2002

Shoreline protection in Dubai



December 2003

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Recap: think about construction when making a design

How can this design be built? What equipment?

Avoid details, especially under water

Keep it simple

Think about required space

Avoid placing heavy items far away

Set reasonable tolerances and layer thicknesses

Reduce # of layers where possible

Reduce # of materials where possible

Do we really need a geotextile?

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